

What is claimed is:

1. A plasma processing apparatus for processing a substrate with plasma by applying a high frequency to a reaction chamber so as to generate plasma therein, and applying a second high frequency to a substrate holder on which the substrate is placed so as to control the ion energy to the substrate; wherein

a surface portion of an inner wall of the reaction chamber that is directly exposed to plasma is covered with a dielectric, a conductive portion is disposed to a portion of the surface portion covered with dielectric, and a DC earth is disposed to the conductive portion.

2. The plasma processing apparatus according to claim 1, wherein

the dielectric covers 90 % or more of a total surface area that is directly exposed to plasma, and the conductive portion has an area corresponding to less than 10 % of the inner wall area of the reaction chamber.

3. The plasma processing apparatus according to claim 1, wherein

the conductive portion has an area corresponding to 0.1 % to 10 % of the area of the inner wall of the reaction chamber.

4. The plasma processing apparatus according to any one of claims 1 through 3, wherein

the DC earth is located at a position where a floating potential of plasma is substantially equal to or greater than the floating potential of plasma at either the inner wall of the reaction chamber covered with the dielectric or a surface of an earth member disposed on the inner wall of the reaction chamber, with respect to said high frequency or said second high frequency.

5. The plasma processing apparatus according to any one of claims 1 through 4, wherein

the dielectric is a protective coating formed of insulating ceramic such as carbide, oxide or nitride, as exemplified by SiC, boron carbide and alumite, and a thickness d of the dielectric coating is determined so that, with respect to the relationship between frequency f of the high frequency applied to the substrate and the dielectric constant ϵ of the dielectric, an impedance per unit area $R = d / (2\pi f \epsilon)$ when said high frequency is propagated by capacity coupling through the dielectric portion is 100Ω or smaller.

6. The plasma processing apparatus according to any one of claims 1 through 5, wherein

a magnetic field generation means is disposed outside the reaction chamber to apply magnetic field to the plasma, and the DC earth is disposed at a position crossing a magnetic line of force that is closer to the substrate holder than a magnetic

line of force that crosses either the inner wall of the reaction chamber having the dielectric coating or a surface of an earth member disposed on the inner wall of the reaction chamber.

7. The plasma processing apparatus according to any one of claims 1 through 6, wherein

either a base material of the DC earth or a protective coating disposed on a surface of the DC earth coming into contact with plasma is composed of conductive ceramic, SiC, Al or Al compound.

8. The plasma processing apparatus according to any one of claims 1 through 6, wherein

when a base material of the DC earth is composed of a non-metallic material such as conductive ceramic, SiC, Al or Al compound, a conductive member having a conductivity σ of 1 Ωcm or less is provided to the mounting surface of the DC earth by evaporation, spraying or interposing, thereby reducing the earth resistance of the DC earth.

9. A plasma processing method for processing a substrate with plasma by applying a high frequency to a reaction chamber so as to generate plasma therein, and applying a second high frequency to a substrate holder on which the substrate is placed so as to control the ion energy to the substrate; comprising

covering 90 % or more of a total surface area of an inner wall of the reaction chamber that is directly exposed to plasma

with a dielectric, and disposing a DC earth comprising a conductive portion that is earthed and having an area less than 10 % of the inner wall of the reaction chamber; and

performing plasma processing to the substrate in the reaction chamber having said DC earth located at a position where a floating potential of plasma is higher than the floating potential of plasma at the inner wall of the reaction chamber that is closest to the substrate.